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EM Design and Analysis of Antenna Enclosed Ground-Based Radome

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Outline

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2. Types of Radomes
3. Parabolic Reflector Antenna
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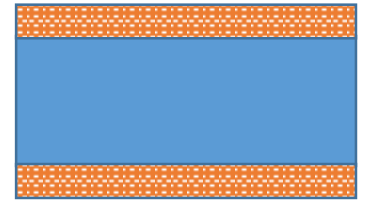
Introduction

- Radomes are protective covers for antennas
- Radomes provides
  - Nominal temperature
  - Less frequent and simpler maintenance
  - Increased life cycle
  - Safe and congenial working area for personnel
- Some of the applications using radomes are
  - Weather and telecommunication radars
  - Aircrafts
  - Satellite communications
  - Air traffic control and maritime communication
- A proper method of analysis of radome antenna interaction is necessary.

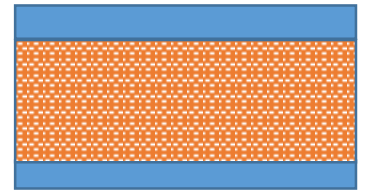
A Ground Based Spherical Radome [8]

Types of Radomes

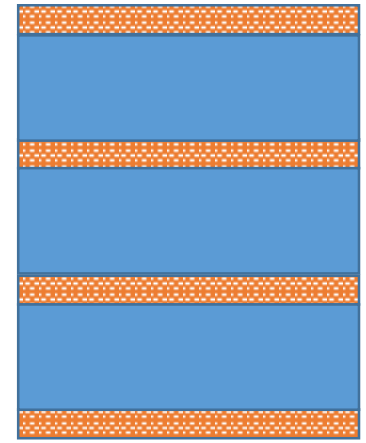
- Radomes are classified based on different criteria.
  - Skin construction
  - Way of radome support
  - Shape of radome
- Based on skin construction radomes can be
  - Monolithic (plain thin dielectric)
  - Sandwich
    - ✓ A-Sandwich
    - ✓ A-Sandwich Honeycomb
    - ✓ B-Sandwich
    - ✓ C-Sandwich
    - ✓ More than five layer



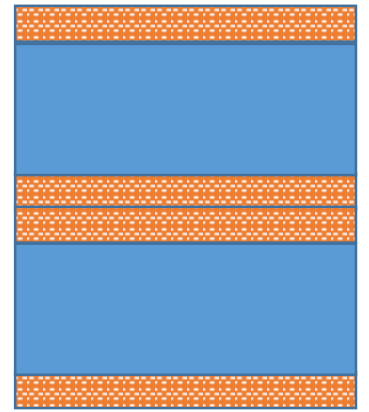
A-Sandwich



B-Sandwich



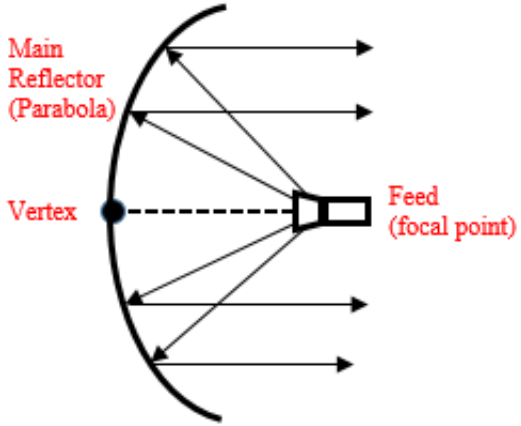
More than five layer



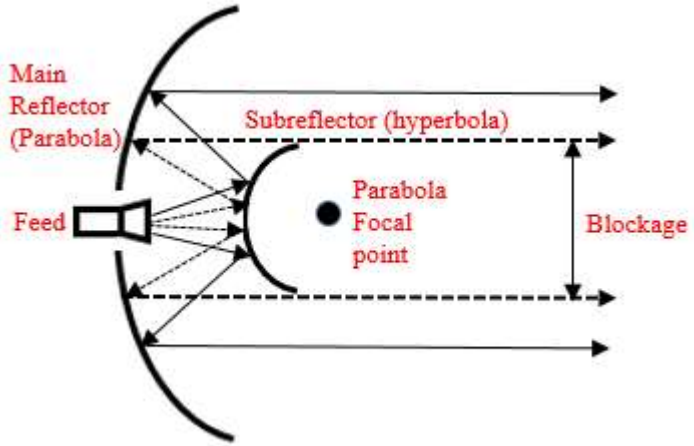
C-Sandwich

Parabolic Reflector Antenna

- Parabolic reflector antennas are high gain and directive antennas
- It consists of two parts
  - A reflecting surface
  - feed antenna
- Based on the feed position there are generally two configurations for reflector antennas
  - Front fed arrangement
  - Cassegrain feed arrangement



Front fed arrangement

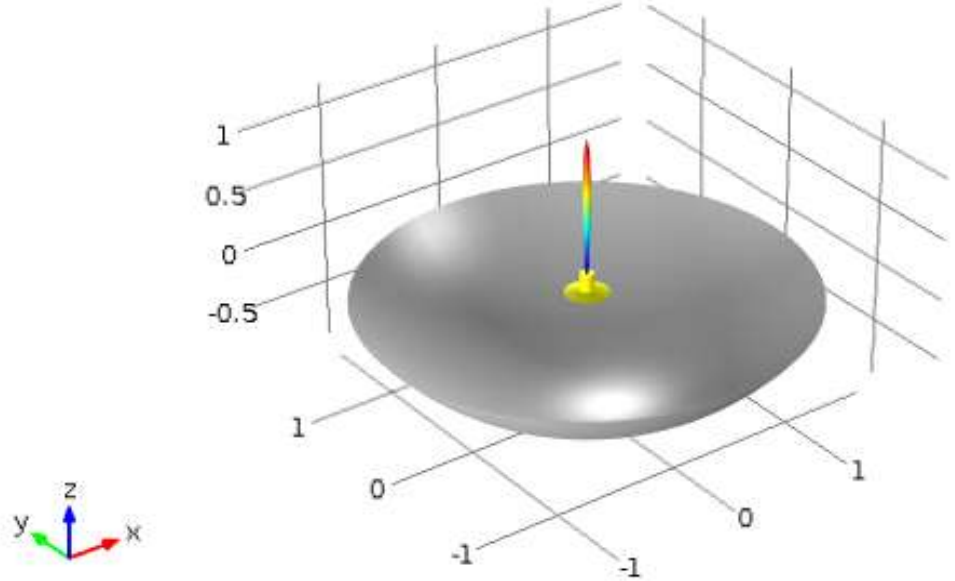


Cassegrain feed arrangement

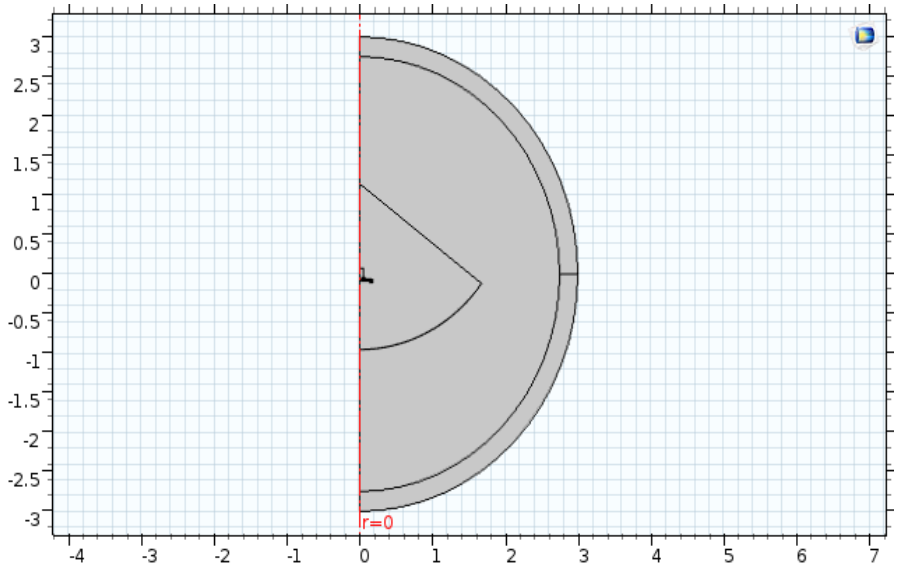
Parabolic Reflector Antenna Design

Table 1: Antenna parameters

Parameter	value
Reflector radius	2.1 m
Feed horn radius	0.054 m
Frequency	1.789 GHz
Horn length	0.028 m



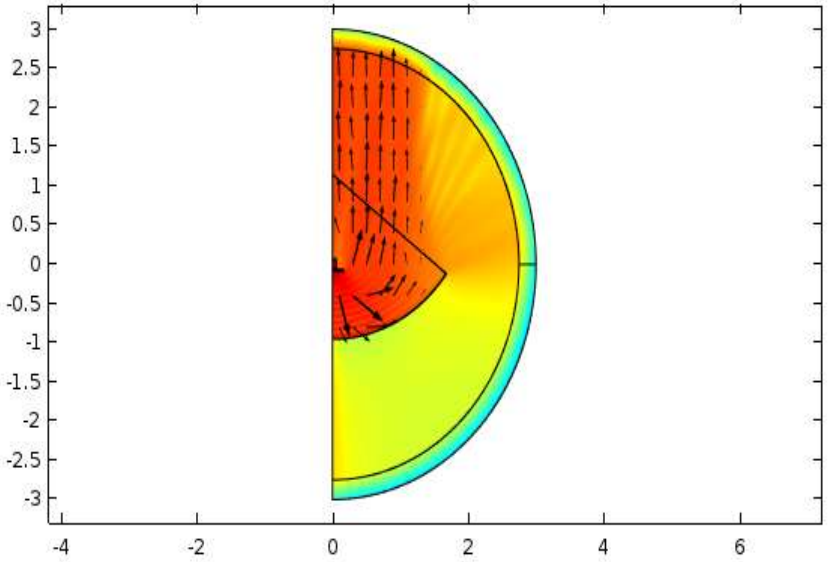
3D radiation pattern visualized over the feed and parabolic reflector



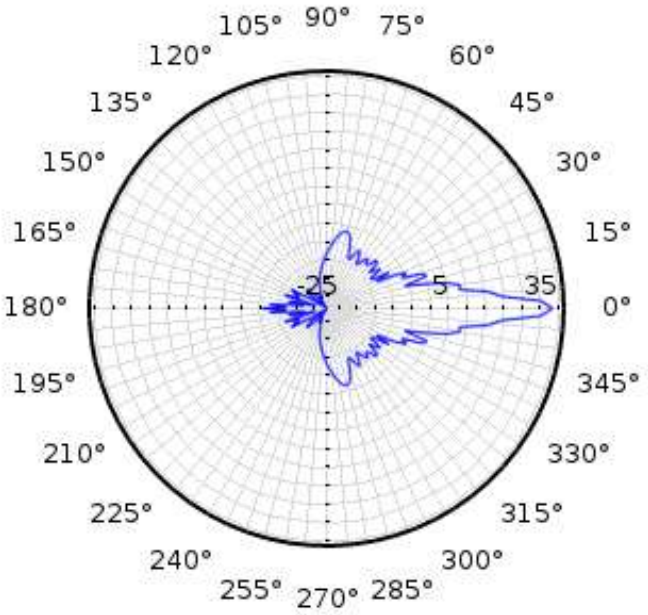
Schematic diagram

Table 2: Parameters estimated

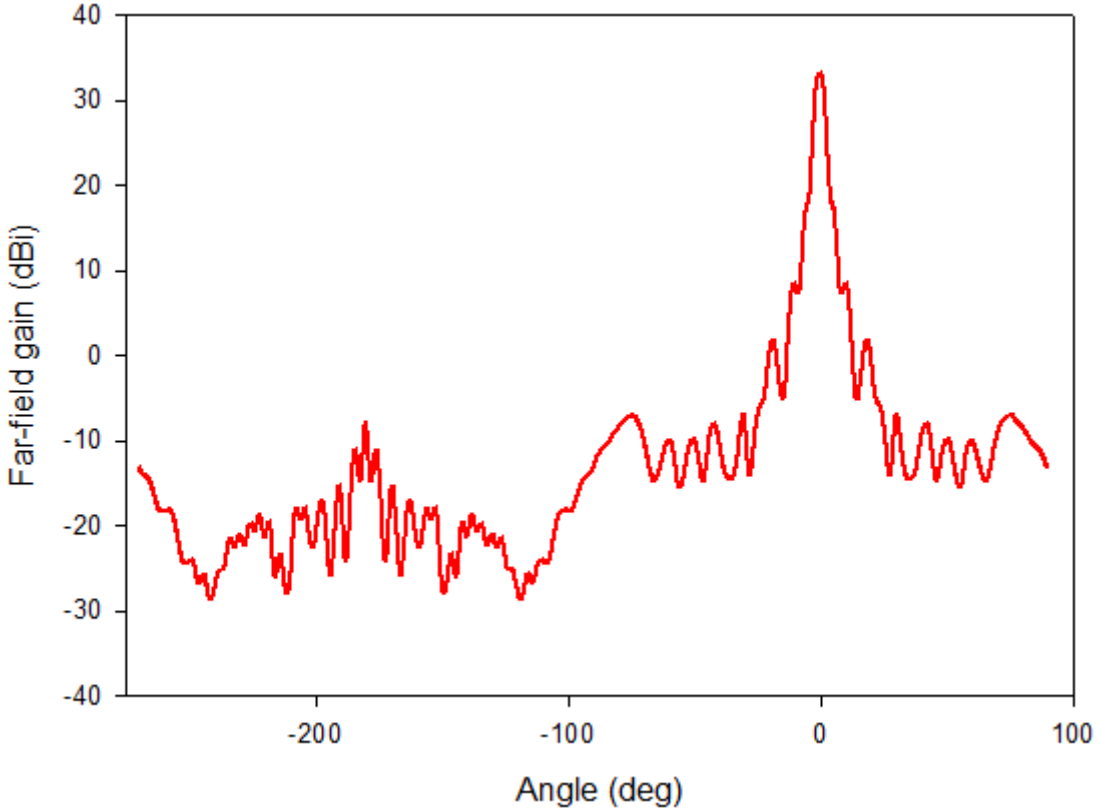
Parameters	Value
Maximum Gain (dB)	33.206
S11 (dB)	-16.89
VSWR	1.33



Electric field propagating in Z-direction



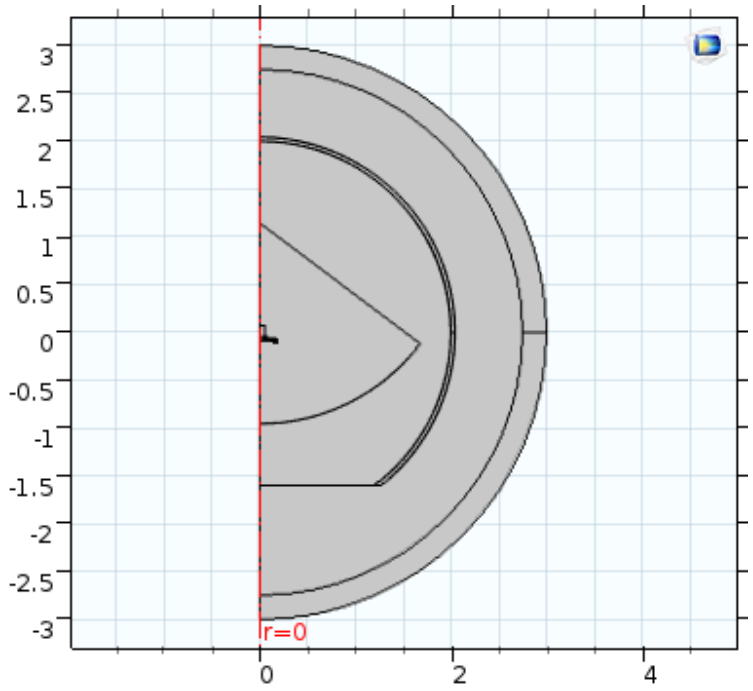
2D plot of Far-field gain in dBi



Linear plot of Far-field gain in dBi

A-Sandwich Radome Design

- The parabolic reflector antenna enclosed hemispherical radome structure of three layers
  - E-glass epoxy for the outer layers
  - PU Foam for middle layer.



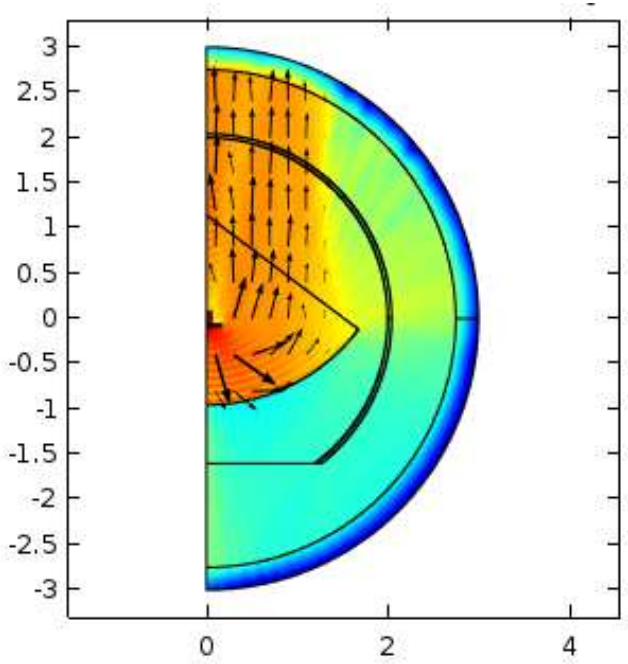
Schematic diagram

Table 3: Radome parameters

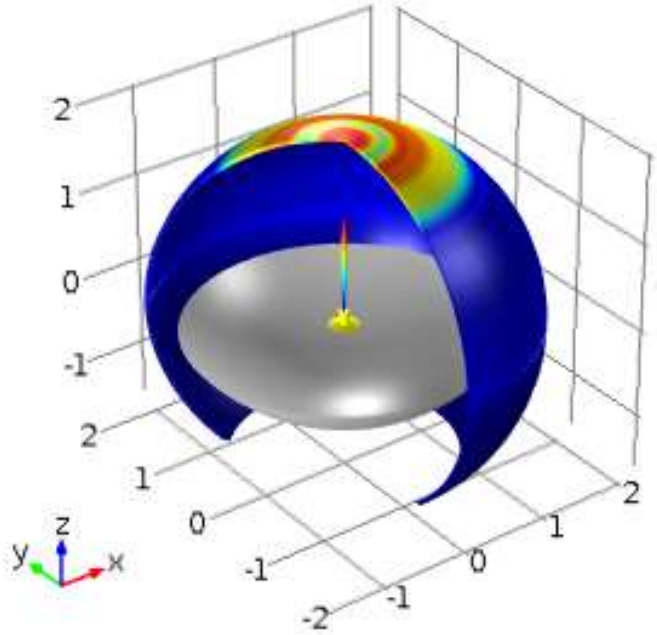
	Layer1	Layer2	Layer3
Thickness *d*	3.9mm	41mm	3.9mm
Permittivity ε_r	4.2	1.15	4.2
Loss tangent tanδ	0.026	0.0098	0.026

Table 4: Parameters estimated

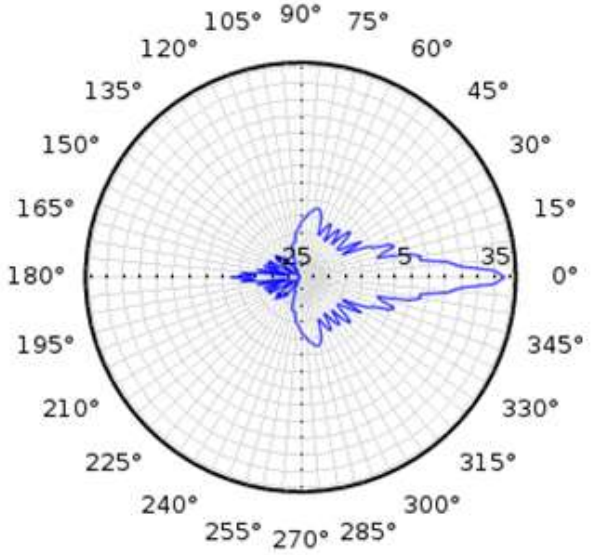
Parameters	Value
Maximum Gain (dB)	33.1373
S11 (dB)	-16.988
VSWR	1.33



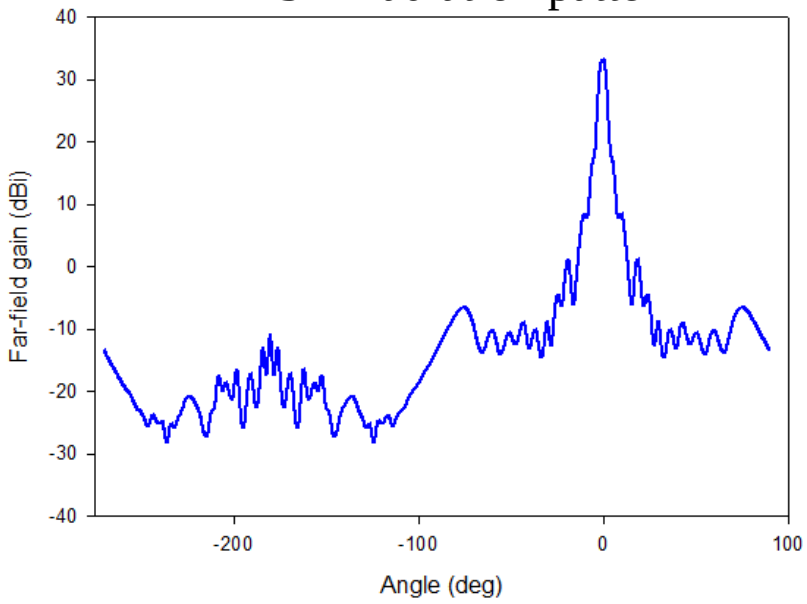
Electric field propagating in Z-direction



3D Radiation pattern

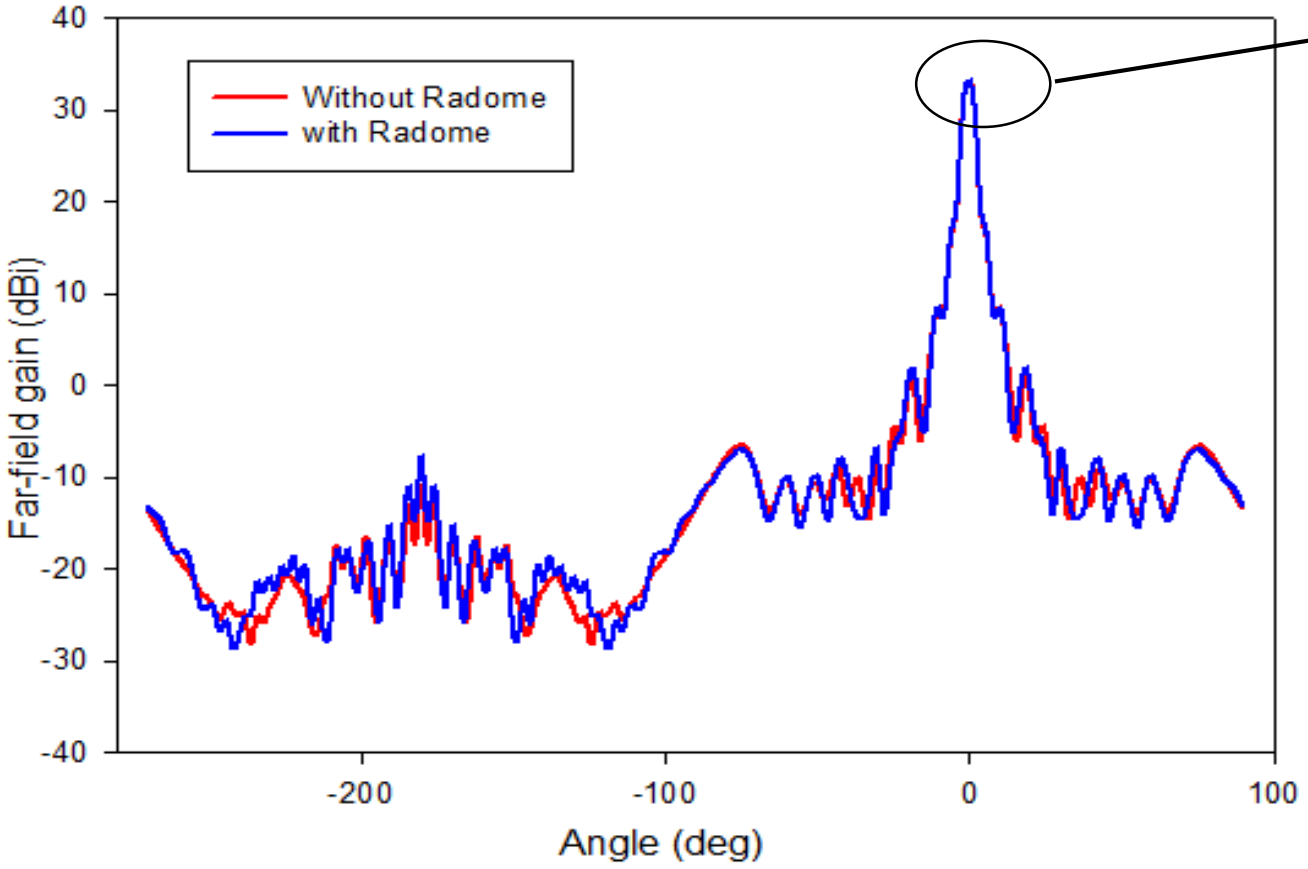


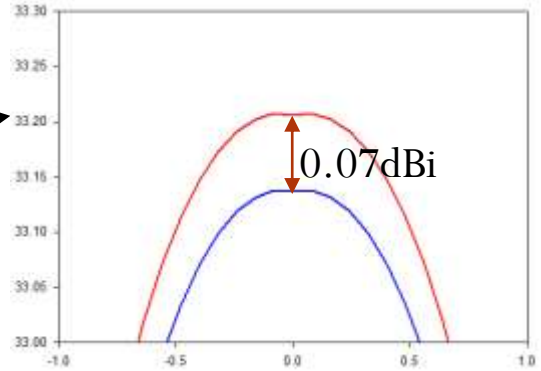
2D plot of Far-field gain in dBi



Linear plot of Far-field gain in dBi

Comparison Plot





zoomed view of tips of the main lobes

Far-field gain of parabolic reflector antenna with and without A-sandwich radome

Conclusion

- The main lobe of the radiation pattern remains almost unaffected.
- The presence of radome creates a little rise in the side lobe level.
- The designed radome have negligible affect on the EM characteristics of the parabolic reflector antenna.

References

[1] Mashury Wahab , “Radar Radome and Its Design Considerations”, International Conference on Instrumentation, Communication, Information Technology, and Biomedical Engg, Nov. 2009.

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[6] Kirti Chaurasiya, and Satish Kumar, “Design and Analysis of Parabolic Reflector Using MATLAB ”, Int. J. of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 4, Issue 3, March 2015

[7] https://www.comsol.co.in/model/parabolic-reflector-antenna

[8] https://en.wikipedia.org/wiki/Parabolic_antenna

THANK YOU